LISTING OF THE CLAIMS

1. (Cancelled) A bipolar band-to-band infrared photodetector-diode, or laser diode, or light emitting diode, or amplifier, or electrooptic modulator-diode comprising

   (a) a silicon substrate,

   (b) a strain-relaxed $Ge_{1-y}Sn_y$ or $Ge_{1-y-z}Sn_ySi_z$ buffer layer upon Si, known as a virtual substrate, VS

   (c) an active direct-bandgap region made up of a single-quantum-well heterostructure or a multi-quantum-well stack,

   (d) a strain-relieved capping layer of $Ge_{1-y}Sn_y$ or $Ge_{1-y-z}Sn_ySi_z$ matching the VS composition,

   (e) metallic electrical contacts to the Si substrate and/or capping layer.

2. (Cancelled) The devices of claim 1 wherein the substrate is doped N-type or P-type while the capping layer is doped P-type or N-type to form an NIP or PIN diode,

3. (Amended) [The devices of claims 1,2 wherein the VS is $Ge_{1-y}Sn_y$ and the active region is a strain balanced type-I stack of compressive $Ge_{1-2y}Sn_{2y}$ quantum wells with tensile Ge barriers.

A biopolar band-to-band infrared photodetector-diode, or laser diode, or light-emitting diode, or amplifier, or electrooptic modulator-diode comprising

(a) a silicon substrate, wherein the substrate is doped N-type or P-type while the bapping layer is doped P-type or N-type to form an NIP or PIN diode,

(b) a strain-relaxed $Ge_{1-y}Sn_y$ or $Ge_{1-y-z}Sn_ySi_z$ buffered layer upon Si, known as a virtual substrate, VS wherein the VS is $Ge_{1-y}Sn_y$ and the active region is a strain balanced type-I stack of compressive $Ge_{1-2y}Sn2_y$ quantum wells with tensile Ge barriers,

(c) an active direct-bandgap region made up of a single-quantum-well heterostructure or a multi-quantum-well stack,

(d) a strain-relieved capping layer of $Ge_{1-y}Sn_y$ or $Ge_{1-y-z}Sn_ySi_z$ matching the VS composition,

(e) metallic electrical contacts to the Si substrate and capping layer. – –

– – 4. (Amended) the devices of claims [1, 2,] 3 wherein the composition y ranges from 0.02 to 0.15 for device operation at wavelengths ranging from 1.55 to 5.00 μm. – –

– – 5. (Amended) the photodetector devices of claims [1,] 3, [4] in which the substrate is doped N or P type and the cap layer contact is an Schotty barrier metal. – –

– – 6. (Amended) the photodetector devices of claims [1,] 3, [4] in which the substrate is undoped and an interleaved pair of metal electrodes is employed upon the cap layer. – –

– – 7. (Amended) The devices of claims [1, 2] v^3 wherein the VS is $Ge_{1-y}Sn_y$ and the active region is an unsymmetrically strained type-II heterostructure with holes confined in a tensile Ge layer and electrons confined in the relaxed buffer layer. – –

– – 8. The devices of claims [1, 2] v^3 wherein the VS is $Ge_{1-y-z}Sn_ySi_z$ and the active region is an unsymmetrically strained type-I heterostructure with electrons-and-holes confined in a tensile Ge layer. – –

9. (Original) the devices of claim 8 wherein y and z are approximately 0.2.

10. A unipolar intersubband long-wave-infrared photodetector-diode, or laser diode, or light emitting diode, or amplifier, or electrooptic modulator diode comprising:

(a) silicon substrate

(b) strain-relaxed $Ge_{1-y}Sn_y$ buffer layer upon Si, known as a virtual substrate, VS

(c) an active direct-bandgap region made up of a strain-balanced type-I multi-quantum-well stack which has compressive $Ge_{1-2y}Sn_{2y}$ wells and tensile Ge barriers,

(d) a strain-relieved capping layer of $Ge_{1-y}Sn_y$ that matches the VS composition,

(f) metallic electrical contacts to the Si substrate and/or capping layer.

– – 11. (Amended) the photodetector devices of claim 10 wherein the VS and cap and quantum wells are doped N type 0. – –

– – 12. (Amended) the photodector devices of claim 10 wherein the VS and cap and quantum wells are doped P type. – –

– –13. (Original) the laser, emitter, amplifier and modulator devices of claim 10 wherein the VS and cap are both doped N-type or both doped P-type for electron injection or for hole injection, respectively. – –

– –14. (Original) the laser, emitter, amplifier and modulator devices of claim 10 wherein the resonant tunneling of injected carriers is used between adjacent periods of the active region in the manner of a quantum cascade. – –